

# *Hydrogen Safety Panel*

presented by

Steven C. Weiner

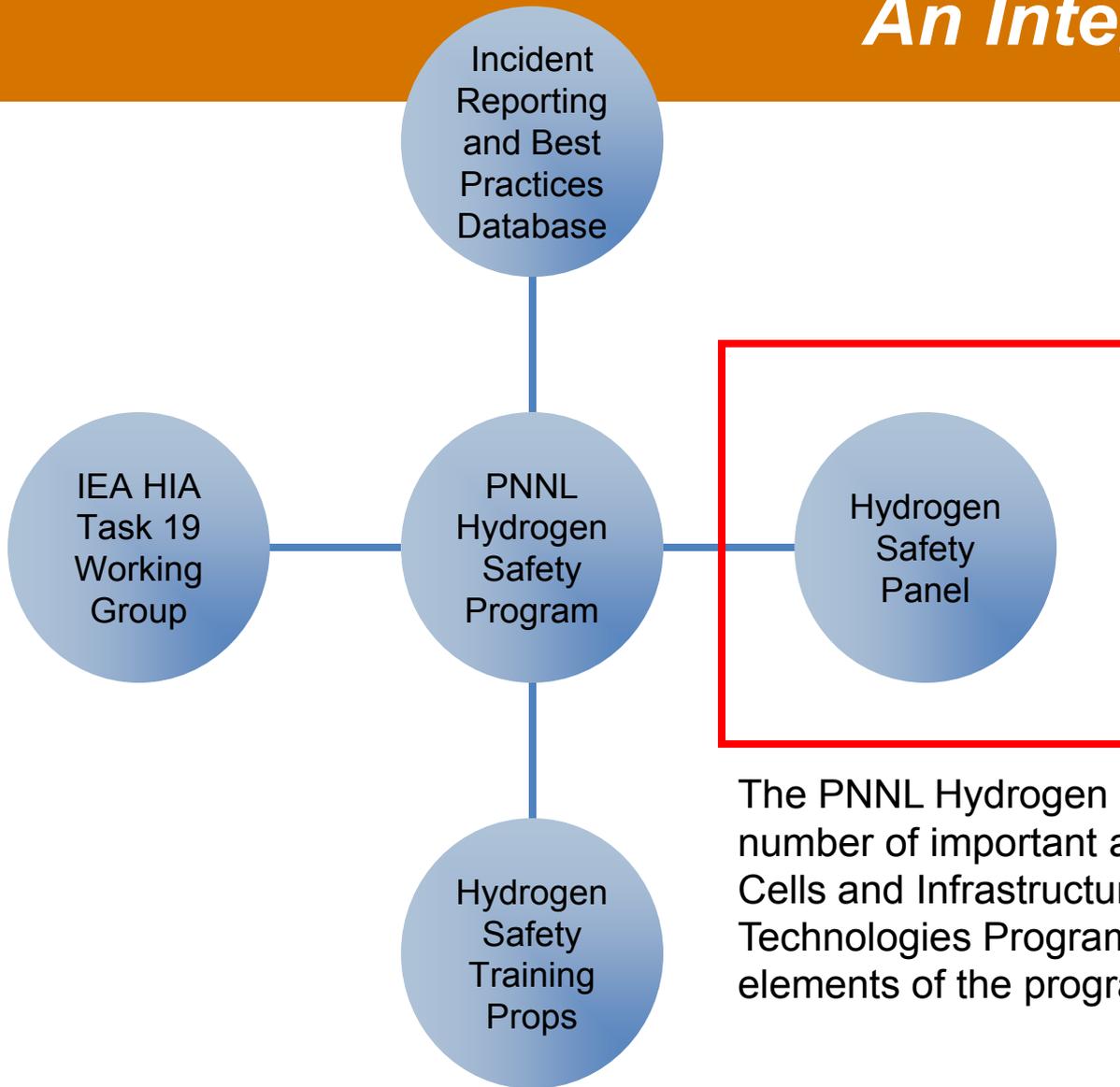
for the

Vehicle Technologies Annual Merit Review

May 22, 2009

This presentation does not contain any proprietary, confidential or otherwise restricted information.

# *PNNL Hydrogen Safety Program An Integrated Approach*



The PNNL Hydrogen Safety Program contributes a number of important activities to the Hydrogen, Fuel Cells and Infrastructure Technologies, and Vehicle Technologies Program Offices. The current main elements of the program are shown here.

# Overview

## Timeline

- First Panel meeting:  
December 11, 2003
- Continuing

## Budget

- FY08 = \$900K
- FY09 = \$850K



Hydrogen Safety Panel at NREL's Wind Technology Center

## Barriers addressed<sup>1</sup>

- E. Variation in standard practice of safety assessments for components and energy systems
- F. Safety is not always treated as a continuing process
- G. Expense of data collection and maintenance

## Partners

- Energetics
- Panel member organizations
- IEA Hydrogen Implementing Agreement

<sup>1</sup>Hydrogen, Fuel Cells & Infrastructure Technologies Program Multi-Year Research, Development and Demonstration Plan, October 2007.



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# Hydrogen Safety Panel

Richard Kallman, Chair	City of Santa Fe Springs, CA
Steven Weiner, Program Manager	Pacific Northwest National Laboratory
Addison Bain	NASA (ret)
Harold Beeson	NASA White Sands Test Facility
David Farese	Air Products and Chemicals
Don Frikken	Becht Engineering
Michael Pero	Hydrogen Safety, LLC
Harold Phillippi	ExxonMobil Research and Engineering
Glenn Scheffler	GWS Solutions of Tolland LLC
Andrew Sherman	Powdermet Inc.
Ian Sutherland	General Motors
Robert Zalosh	Firexplo
Nick Barilo, Technical Support	Pacific Northwest National Laboratory
Ed Skolnik, Technical Support	Energetics



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# Objectives

- ▶ Provide expertise and guidance to DOE and assist with identifying safety-related technical data gaps, best practices and lessons learned.
- ▶ Help DOE integrate safety planning into funded projects to ensure that all projects address and incorporate hydrogen and related safety practices.



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# *What are we trying to achieve?*

- ▶ DOE and the Hydrogen Safety Panel are trying to achieve safe operation, handling and use of hydrogen and hydrogen systems for all DOE projects. That vision will be achieved when
  - Safety-related technical data gaps are identified and addressed.
  - Project teams are aware of relevant issues and best practices that affect safe operation and handling of hydrogen and related systems.
  - Project teams give sufficient priority to safety in their work.



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# Hallmarks of Our Approach

- ▶ Engage Panel members, OEMs, energy companies, international partners, first responders and other stakeholders in all aspects of our hydrogen safety program
- ▶ Focus interactions with project teams on learning, knowledge sharing and encouragement of thorough, continuous and priority attention to safety...rather than as audit or regulatory exercises



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# *Technical Accomplishments, Progress and Results – Safety Planning*

- ▶ Safety planning work expanded with project interaction
  - Reviewed 34 safety plans since the 2008 Annual Merit Review.
  - Project teams provided with additional safety planning feedback (via teleconference) upon request.
  - Assisted the Hydrogen Storage Engineering Center of Excellence in its early stages of project safety planning.
  - Safety plans discussed during site visit safety reviews.
  - Four project safety plans currently identified as “good examples” and others under consideration.



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# *Technical Accomplishments, Progress and Results – Project Safety Reviews*

- ▶ Safety reviews are focused on engagement, learning and discussion with project teams
  - 16 safety reviews conducted/reported in the past two years; 7 additional projects identified and being scheduled.
  - 85 recommendations provided in 8 site visit safety review reports issued to DOE in the past two years.
  - Hydrogen Safety Panel has proposed teleconference follow-up on actions taken by project teams on report recommendations.
    - A metric to help identify actions, conclusions and findings that can have broader benefit in the DOE Hydrogen Program

# *Technical Accomplishments, Progress and Results: Learning from Safety Events*

- ▶ Shell White Plains (NY) Hydrogen Fueling Station: fire destroyed 70 MPa compressor skid (August 21, 2008)
  - Hydrogen Safety Panel members participated in the second phase of the incident investigation.
  - Shell Hydrogen/Air Products discussed the incident at the most recent Panel meeting.
  - Shell Hydrogen/Air Products have posted the incident on “H2Incidents.org”
  - Panel considering follow-on initiatives related to shared learnings from this safety event.



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# *Technical Accomplishments, Progress and Results - Meetings*

- ▶ Conducted two meetings of the Hydrogen Safety Panel
  - 10<sup>th</sup> Meeting, NREL, Golden, CO, June 24-25, 2008
  - 11<sup>th</sup> Meeting, Energetics, Washington, DC, December 10-11, 2008
  - 12<sup>th</sup> Meeting (planned), Powertech Labs, Vancouver/Surrey, BC, Canada, June 23-25, 2009
    - Hydrogen components/systems testing
    - High-pressure fueling facilities
    - Integrated Waste Hydrogen Utilization Project (IWHUP)



# H2 Safety SNAPSHOT: A Safety Knowledge Tool

- ▶ The idea
  - One-page, topical safety bulletin e-published quarterly
- ▶ The audience
  - Project teams in the diverse portfolio of the DOE Hydrogen Program
  - International and other partnerships
- ▶ The approach
  - Panel task group selects topics
  - Utilize guest expert authors
  - Use “snapshot@pnl.gov” to solicit comments and suggestions
- ▶ Endorsed by the Panel to DOE

The image shows a screenshot of the H2 Safety Snapshot newsletter. At the top, it says "H2 SAFETY Snapshot" with a molecular model of H2. Below that, it says "Vol. 1, Issue 1, Nov. 2008". The main content is divided into several sections:

- Welcome!**: A paragraph introducing the newsletter and its purpose.
- CAPTURING a Wealth of Experience**: A section about the H<sub>2</sub> Safety Best Practices online manual and website.
- LEARNING Lessons from Safety Events**: A section about the H<sub>2</sub> Incident Reporting and Lessons Learned database-driven website.
- SEARCHING the Literature**: A section about the Hydrogen Safety Bibliographic Database.

At the bottom, there are logos for the U.S. Department of Energy and Pacific Northwest National Laboratory, along with contact information for suggestions and comments.

# Fuel Cell Vehicle Safety Training Prop

The fuel cell vehicle (FCV) simulator prop demonstrates potential conditions that could be encountered during the control and suppression of a FCV fire. The prop is being integrated into a training course, Hydrogen Safety for First Responders, being developed by the Pacific Northwest National Laboratory and the Volpentest HAMMER Training and Education Center for the U.S. Department of Energy.



A propane flame simulates a compartment fire (1). A hydrogen flame, from vented hydrogen gas, is also simulated by the prop, but is not visible in daylight. This flame can be seen using a thermal imaging camera (2).



Training prop features: (3) mock fuel cell stack, (4) mobile capability, (5) mock hydrogen storage tank.



Volpentest  
**HAMMER**

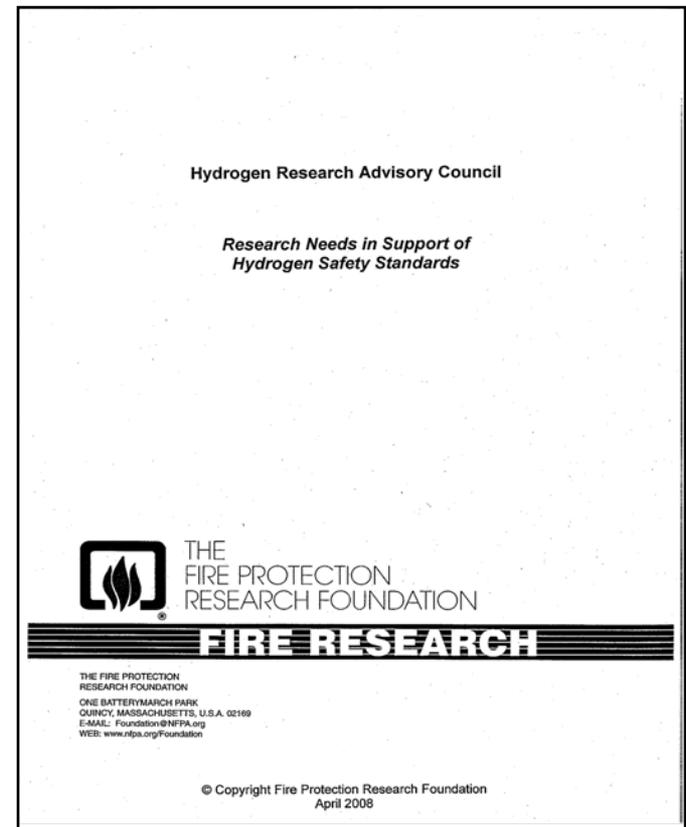
  
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The Hydrogen Safety Panel completed review of the FCV prop safety plan and served as reviewers for the pilot course.

# The Fire Protection Research Foundation Hydrogen Research Advisory Council

- ▶ Identifying research needs in support of hydrogen safety standards
- ▶ Panel endorsed April 2008 report by FPRF and participated in recent follow-on assessing topical areas for need:
  - Explosion modeling
  - Detection (wide-area sensing)
  - Materials (fatigue)
  - Components (PRDs)
  - Confinement (deflagrations in partially confined areas)



# Future Work

## ▶ Remainder of FY2009

- Issue final reports with recommendations for all safety reviews conducted
- Conduct safety review site visits as scheduled
- Begin follow-up on site visit report recommendations
- Review project safety plans
- Complete Panel “white paper” work in progress on 70 MPa fueling and components
- Publish first issue of *H2 Safety SNAPSHOT*
- Propose FY2010 Annual Operating Plan (AOP) to DOE
  - Consider AMR feedback from DOE and reviewers

## ▶ FY2010

- Establish FY2010 work plan and implement



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# *A Summary By the Numbers...*

- ▶ 190 safety plans reviewed
- ▶ 35 safety reviews conducted
- ▶ 11 Panel meetings
- ▶ 4 “good” example safety plans (and more under consideration!)
- ▶ 4 “white paper” recommendations (and more in the works!)
- ▶ 2 incident investigations



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